

## CLAIMS

- 1 1. A method for creating a three-dimensional visual representation of an object  
2 having multiple resolutions, comprising the steps of:
- 3 retrieving coordinates of vertices for the object;  
4 determining a collapse order for the vertices identified in the vertex list;  
5 reordering the vertices identified in the vertex list responsive to the  
6 determined collapse order;  
7 creating a vertex collapse list responsive to the collapse order where the  
8 vertex collapse list specifies, for a target vertex, a neighbor vertex  
9 to collapse to;  
10 using the vertex collapse list and a level of detail to identify at least one  
11 display vertex of the object; and  
12 rendering the display vertex to produce a three-dimensional visual  
13 representation of the object.
- 1 2. The method of claim 1 wherein determining the collapse order comprises the steps  
2 of:
- 3 determining a set of collapse paths;  
4 selecting a collapse path from the set of collapse paths;  
5 computing visual distortion factors for the selected collapse path;  
6 responsive to the computed visual distortion factors, determining a  
7 collapse value for the selected collapse path;

8 repeating selecting a collapse path, computing visual distortion factors,  
9 determining a collapse value for each collapse path;  
10 selecting a next vertex to be collapsed as a vertex having a collapse path  
11 causing the least visual distortion to the object;  
12 collapsing the next vertex to be collapsed along the corresponding collapse  
13 path; and  
14 repeating the above steps until a minimum resolution level is attained.

1 3. The method of claim 2 wherein computing visual distortion factors comprises the  
2 steps of:

3 computing an area change factor for the selected collapse path;  
4 computing an angular deviation factor for the selected collapse path; and  
5 computing a local volume change factor for the selected collapse path.

1 4. The method of claim 3 wherein the computing an area change factor for each  
2 collapse path further comprises:

3 computing an area of the object after collapsing the target vertex along the  
4 collapse path; and  
5 subtracting the computed area from an area of the object prior to the  
6 collapse.

1 5. The method of claim 3 wherein the computing a volume change factor for the  
2 selected collapse path comprises:

3 computing a volume of the object after collapsing the target vertex along  
4 the collapse path;

5 subtracting the computed volume from a volume of the object prior to the  
6 collapse.

1 6. The method of claim 5, wherein the step of computing a volume further  
2 comprises:

3 selecting the target vertex to be an apex for a pyramid;  
4 forming a base of the pyramid from a triangle connecting three  
5 consecutive neighbor vertices to the target vertex;  
6 computing a volume of the pyramid;  
7 constructing a next pyramid from a next set of three consecutive neighbor  
8 vertices;  
9 computing a volume of the next pyramid;  
10 repeating the constructing a next pyramid and computing a volume steps  
11 for all unique three consecutive neighbor vertex sets; and  
12 summing the volumes of the pyramids to obtain a volume of the object.

1 7. The method of claim 2 further comprising the step of receiving an input from a  
2 user specifying a priority weight for a visual distortion factor, and the determining a  
3 collapse value step further comprises, responsive to the computed visual distortion factors  
4 and priority weights, determining a collapse value for the selected collapse path.

1 8. The method of claim 2 wherein, responsive to collapsing the next vertex to be  
2 collapsed along the corresponding collapse path, collapse paths local to the next vertex  
3 are identified and the computing visual distortion factors for the selected collapse path

4 and the determining a collapse value for the selected collapse path steps are repeated only  
5 for the local collapse paths.

1 9. The method of claim 2 wherein determining a set of collapse paths further  
2 comprises:

3 selecting a target vertex;  
4 receiving input specifying a maximum number of neighbor vertices for a  
5 target vertex;  
6 identifying a number of neighbor vertices, responsive to the received  
7 input;  
8 determining a collapse path responsive to coordinates of the target vertex  
9 and an identified neighbor vertex;  
10 repeating the determining step for all identified neighbor vertices;  
11 repeating the selecting a target vertex, identifying, determining, and  
12 repeating steps for a plurality of vertices.

1 10. The method of claim 2 further comprising the steps of:

2 responsive to selecting a collapse path, displaying the object prior to  
3 collapsing the object along the selected path;  
4 collapsing the object along the specified path;  
5 displaying the object after being collapsed along the specified path;  
6 responsive to receiving an input selecting the collapse path, storing the  
7 collapse path and corresponding vertex on the collapse order list as  
8 the next vertex to be collapsed.

1 11. The method of claim 1, further comprising receiving an input specifying a set of  
2 minimum vertices, and the determining collapse order step further comprises determining  
3 a collapse order in which the specified set of minimum vertices are not collapsed.

1 12. The method of claim 1 wherein multiple resolution levels of the object exist,  
2 further comprising the steps of:  
3 ordering the resolution levels from highest to lowest resolution;  
4 selecting a highest resolution level for collapsing;  
5 the determining a collapse order step comprises determining a collapse  
6 order for the highest resolution level, wherein vertices in the next  
7 lowest resolution level are not collapsed; and  
8 repeating the selecting and determining steps for each resolution level.

1 13. The method of claim 1 wherein the vertex coordinates are associated with vertex  
2 attributes.

1 14. The method of claim 2 wherein the vertices have coordinates in a texture map,  
2 further comprising the steps of:  
3 responsive to a selected collapse path collapsing a first vertex into a  
4 second vertex to create a new vertex, assigning the texture map  
5 coordinates of the second vertex to the new vertex;  
6 responsive to the first and second vertex being on an edge of a texture  
7 discontinuity, identifying the collapse path as a collapse path not to  
8 be used.

1 15. The method of claim 2 wherein the vertices have coordinates in a normal map,  
2 further comprising the steps of:

3 responsive to a selected collapse path collapsing a first vertex into a  
4 second vertex to create a new vertex, assigning the normal map  
5 coordinates of the second vertex to the new vertex.

1 16. The method of claim 2 wherein the vertices have coordinates in a color map,  
2 further comprising the steps of:

3 responsive to a selected collapse path collapsing a first vertex into a  
4 second vertex to create a new vertex, assigning the color map  
5 coordinates of the second vertex to the new vertex; and  
6 responsive to the first and second vertex being on an edge of a color  
7 discontinuity, identifying the collapse path as a collapse path not to  
8 be used.

1 17. A method for displaying an object, wherein a vertex list and a neighbor list is  
2 stored for the object, and vertices in the vertex list are identified by a collapse priority,  
3 and the neighbor list identifies the path of a collapse for the vertices, comprising the steps  
4 of:

5 performing a collapse of the object responsive to the vertex list and  
6 neighbor list;  
7 storing vertex information for each collapse level, wherein the vertex  
8 information indicates which vertices exist in the object in the

9 collapse level immediately higher and lower than the current  
 10 collapse level;  
 11 receiving input requesting a collapse level for the object;  
 12 responsive to the requested collapse level requiring a higher resolution  
 13 than a current collapse level, adding vertices to the vertex list for  
 14 the object responsive to the vertex list and stored vertex  
 15 information;  
 16 responsive to the requested collapse level requiring a lower resolution than  
 17 a current collapse level, collapsing vertices in the vertex list of the  
 18 object responsive to the vertex list and stored vertex information;  
 19 and  
 20 rendering the vertices in the vertex list to produce a three-dimensional  
 21 visual representation of the object.

- 1 18. The method of claim 17 further comprising the step of:  
 2 storing extended collapse information, wherein the extended collapse  
 3 information includes triangle connectivity information for the  
 4 vertices.
- 1 19. A method for displaying an object, wherein a vertex list and a neighbor list is  
 2 stored for the object, and vertices in the vertex list are identified by a collapse priority,  
 3 and the neighbor list identifies the path of a collapse for the vertices, comprising the steps  
 4 of:

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5 performing a collapse of the object responsive to the vertex list and  
6 neighbor list;  
7 storing vertex information for each collapse level, wherein the vertex  
8 information indicates which vertices exist in the object in the  
9 collapse level immediately higher and lower than the current  
10 collapse level;  
11 analyzing the object to determine a collapse level;  
12 responsive to the determined collapse level requiring higher resolution,  
13 adding vertices to the vertex list for the object responsive to the  
14 vertex list and stored vertex information;  
15 responsive to the determined collapse level requiring a lower resolution,  
16 collapsing vertices in the vertex list for the object responsive to the  
17 vertex list and stored vertex information; and  
18 rendering the vertices in the vertex list to produce a three-dimensional  
19 visual representation of the object.

1 20. The method of claim 19 wherein the step of analyzing the object further  
2 comprises:

3 determining a velocity of the object; and  
4 determining a projected area of the object.

1 21. The method of claim 20 wherein the step of analyzing the object further  
2 comprises:

3 determining the number of polygons currently being displayed;



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4 comparing the determined number to a predefined target number of  
5 polygons; and  
6 responsive to the number of polygons currently being displayed being less  
7 than the predefined number, adding polygons to the object.

1 22. The method of claim 19 wherein the step of analyzing the object further  
2 comprises:

3 determining a current frame rate;  
4 comparing the current frame rate to a predefined frame rate; and  
5 responsive to the current frame being less than the predefined frame rate,  
6 collapsing vertices in the object.

1 23. A method for transferring data across a remote connection, in a system in which a  
2 minimal resolution of an object is stored and separate packets of information comprising  
3 data for creating higher resolutions of the object are stored, comprising the steps of:

4 receiving a request for a transmission of an object to be displayed;  
5 transmitting a minimal resolution version of the object responsive to the  
6 received request;  
7 transmitting a packet of information comprising data for creating a next  
8 higher resolution of the object;  
9 determining whether a target resolution of the object has been met; and  
10 responsive to a target resolution of the object not being met, repeating the  
11 transmitting a packet of information comprising data for creating a  
12 next higher resolution of the object step.